ISSUES IN YAM MINISETT TECHNOLOGY TRANSFER TO FARMERS IN SOUTHEASTERN NIGERIA

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Executive summary

The overall purpose of this study was to identify policy issues in the transfer of yam minisett technology to farmers. Specifically, the study sought to identify which farmer, technology or community issues influence the use of this technology. The transferred technology includes the following: size of ware tubers for cutting; cutting into sets; air drying; application of minisett dust; curing; spacing; planting depth; time of planting; and intercropping patterns. Data for the study was collected from 191 agricultural technology transfer agents (extension agents), 388 farmers and 40 agricultural communities from five of the seven states in southeastern Nigeria. Data gathering techniques involved the use of focus group discussions for community data, an interview schedule for farmers, and a questionnaire for extension agents. Descriptive statistics, step-wise multiple regression, discriminant and factor analysis were used in examining and organizing data for policy implication.

Generally, the proportion of farmers using the technology items listed above was low (9%-17%), and for most of the technology items, more than one third of the farmers initially adopted and later rejected them. There was evidence of modification of the recommended technology items, particularly for items requiring measurements, hired labour, loan and considerable use of time. Items which limited the use of the technology were the size of tuber for cutting, cutting of sets, spacing and mixed cropping patterns.

The results show a positive relationship between the annual number of farmers using the technology and the corresponding annual technology transfer effort. Issues which significantly distinguished between a low and high adoption of the technology include: yam cultivation experience, percentage of total farm land devoted to yam cultivation, participation in social organization, number of times farmers received information on the technology and proportion of yam farm devoted to yam minisett technology.

Farm communities which showed higher probability of accepting and using the yam minisett technology were characterized by a low level of knowledge of ware yam production, were located at least six kilometers away from a major ware yam market, and had an agricultural technology transfer agent with a few years of extension experience. Farmers identified five factors which limited their use of the technology: poor marketing facilities, cultural complexity, complex technology process, lack of input and difficulty in acquiring knowledge about the technology.

Some of the major ways of enhancing the acceptance and use of the technology suggested by farmers include providing and subsidizing needed inputs, government intervention in the marketing of the technology product and review of some technology items (size of planting sets and intercropping pattern). The study concluded that the yam minisett technology was transferred without explicit policy guidance. Issues of importance to the formulation of such a policy have been identified and recommended.

Chapter One: Introduction

1.1 The problem

Yam, (*Discorea spp.*) ranks second after cassava in the production of carbohydrate in West Africa (Sodik, 1976). It represents about 20% of the daily calorie intake of Nigerians living in the forest and savannah regions (Iwueke, et al., 1983) and constitutes a major staple food for the majority of inhabitants of Nigeria. Although yams are grown throughout Africa, production is presently confined to the yam zone, comprising Cameroun, Nigeria, Benin, Togo, Ghana, and Côte d'Ivoire. This zone produces more than 90% of the total world production (Hahn et al., 1987), which is about 20-25 million tons per annum (IITA, 1995). Nigeria cultivates about 69% of the world's total hectarage with yam, out of which the southeastern states provide 40% of the land area (Onwueme, 1978), about 40% of Africa's total yam output (Dorosh, 1988), and 76% of total world output (Coursey, 1983).

There has been a general decline in yam production in Nigeria over the years, (IITA, 1983). Awa (1990) showed that both the area under yam cultivation and total yam output declined at a compound rate of 1.83% and 1.49% per annum respectively between 1960/61 and 1987/88. The decline in production is linked to labourious cultivation methods, the need for staking, and the high cost of scarce seed yams, which are also needed for consumption. This encourages the competition between edible tubers and tubers used as planting materials. The prices of ware yams, or tubers weighing 500g and more, are so high that this staple food item cannot be purchased in sufficient quantity for food or for farming (Ebong & Peter, 1995). Thus, a major constraint to increased production of yams in Nigeria is the lack of seed yams. Seed yam cost constitutes 62% of total outlay (Okorji and Obiechina, 1993). Studies have shown that for some three decades, demand for yam products exceeds supply (Olayide et al., 1972; Okorji, 1988).

To overcome the problem of unavailability of seed yams, a new technology which rapidly provides seed yams — yam minisett technology — was developed by the National Root Crop Research Institute (NRCRI), Umudike, Nigeria, with the aim of alleviating some of the problems associated with large-scale production of seed yams (FARTS, 1975; Okoli et al., 1982; NRCRI, 1985). The Ministries of Agriculture, and later the Agricultural Development Projects (ADPs) — the agencies responsible for the agricultural extension program in Nigeria — have disseminated the technology to farmers in the country for more than ten years.

The technology involves essentially the cutting of yam tubers to produce as many minisetts as possible, 25g each and approximately 2 cm thick with some portion of the cuticle (back) attached. The minisett is then used to produce seed yam which will be used to produce ware yams for consumption and industrial use. About 15-20 minisetts can be obtained from an average seed yam. By using a 25g minisett at a density of 40,000 stands per hectare, one tonne of planting materials could produce 13.6 tons of seed yams per hectare. This is four times the yield obtained from the normal practice. Apart from increased yield, other advantages of the technology include suppression of weeds due to reduced spacing, and increased plant population, (Chinaka et al., 1992). In addition, the technology lends itself to tractors. Despite these comparative advantages, acceptance and use of the technology by farmers to boost yam production has been far from encouraging (Okorji and Obiechina, 1985; Onyenwaku and Mbuba, 1991). Specifically, which aspects of the technology package are responsible for the low acceptance? Could research or extension work enhance their use? What is the rate of use of the yam minisett technology among farmers? What specific items in the technology package are used and why? What specific farmer-related factors limit use of the yam minisett technology?

Is the yam minisett technology appropriate? Technology is appropriate if it is relevant to farmers' situation or circumstances (Kurwijila, 1991). If not, could it be oriented towards the farmers' needs and farm practices by alleviating existing constraints? Who are the potential high users of the technology?

Agricultural technology includes new farm inputs and techniques or practices, (Sofranco, 1984). The inputs include fertilizers, insecticides, herbicides, irrigation systems, plant varieties, livestock breeds, etc. The new techniques could be planting, cultivation, cropping sequence and rotation, storage, and use of animal power, etc.

1.2 Research objectives

The overall objective of this study was to identify policy issues in yam minisett technology transfer to farmers. The specific objectives were to:

1. determine technology-related factors influencing use of the yam minisett technology;
2. examine farmer-related factors limiting the use of the technology;
3. develop criteria for classifying farmers and communities into potential high and low adopters prior to technology transfer; and
4. identify ways of removing the limiting factors preferred by farmers.

1.3 Yam minisett technology generation

Agricultural technology generation has been conceptualized as a research institution system designed to produce improved technologies and the knowledge to be used by the agricultural sector (Adedipe, 1995). According to him, for the technologies developed to have impact on the production system, they must be economically viable, technologically feasible and culturally compatible with the production system.

The yam minisett technology was developed by the National Root Crops Research Institute, Umudike. The technology as disseminated to farmers could be grouped into the following nine identified activities, steps or items:

1. **size of tuber for cutting:** select healthy tubers without bruises. Use yam tubers of 20-25cm length and 25cm girth (500–750g). Avoid yam tubers with bigger girth.
2. **cutting into minisett:** cut each of the yam tubers into horizontal sections (discs), 2cm thick. Secondly, vertically cut each 2cm thick disc into 2, 3 or 4 pieces such that each set weighs 25–30g;
3. **air drying:** allow an interval of 4–5 minutes for ambient air to reduce mucilage on the cut surfaces to avoid the set absorbing the minisett dust;
4. **application of minisett dust:** put the minisetts into a container with lid or in a polythene bag. Add the minisett dust (Apron plus or Fernasan D — one packet of minisett dust, 10g, is enough for 200 minisetts) and shake the container to ensure that the minisetts are evenly dusted;
5. **curing:** spread the minisetts on a dry floor and plant a day later to allow curing of the cut surfaces;
6. **spacing:** plant minisetts at a distance 25cm apart on one-metre ridges or beds. This gives 40,000 stands per hectare;
7. **planting depth:** open the soil up to 9cm deep, drop a minisett and cover it; shallow planting leads to sets drying out or being exposed by rain;
8. **time of planting:** plant a day after rains as rains become regular (May/June);
9. **intercropping:** plant yam 25cm on the crest of the ridge. Mark out 12.5cm before the first stand. Plant maize 1m apart on two sides of alternate furrows. Mark out 50cm before the first stand.

1.4 Concept and structure of agricultural technology transfer in Nigeria

Transfer of agricultural technology is an expression that suggests a whole range of forms through which technological knowledge is transmitted from suppliers to recipients. Technology transfer implies that the recipients of the transfer acquire technical knowledge that underlies formulae, design and production systems, (Okono, 1994).

Agricultural technology transfer is a process with multiple functions which include information, teaching, technology supply and technology service (Asiabaka, 1991). It is the entire process of moving an agricultural technology from source to the farmers

(Ayichi, 1995). Transferring implies conveying information and advice regarding the adoption of technologies and practices. The transfer usually involves building up an extension-research link which will ensure that appropriate technologies are generated. Mijindabi (1994) identified four major elements critical in an agricultural technology transfer process. First is the identification of the problems and needs of potential end users. Second, is the testing and adaptation of new technologies to the local environment of the users. Third is the existence of government or official regulations to provide a decision mechanism for the approval and release of new technologies to users. Fourth is the effective operation of the communication process for ensuring that approved technologies are passed on to users, where applicable, through the extension services system. Adedipe (1995) conceptualized agricultural technology transfer as the institution that will propagate or extend the new improved technologies to the end-users.

The key elements involved in the agricultural technology transfer system in Nigeria include diagnostic surveys (problem identification) on-farm adaptive research (OFAR), monthly technological review meetings (MRTMS), small plot adoption techniques (SPAT), and extension staff training – fortnightly training (FNT) and block meetings.

The Agricultural Development Program (ADP) is the agency with the major responsibility for agricultural technology transfer. There exists one such agency in each of the thirty states in the country. This agency receives agricultural technology tested during OFAR from research agencies through the MTRM. The MTRM is composed of agricultural experts from research institutions and universities on the respective technology for a particular meeting, zonal and headquarters staff from ADP and staff of the Federal Agricultural Coordinating Unit (FACU), the agency responsible for coordinating the activities of ADPs in the country.

In each state, the ADP is divided into three to six geographical demarcations known as agricultural zones. A zone, headed by a zonal manager, has in addition a zonal extension officer and subject matter specialist (SMS) for relevant agricultural areas such as crop, livestock, fishery, and women in agriculture (WIA). They are responsible for organizing the fortnightly training (FNT) for block supervisors and extension agents in a zone. During the training, agricultural technologies discussed at the MTRM are handed over to the block supervisors and extension agents. Field experiences of extension agents are also discussed and farmers' problems articulated for backward transfer to the MTRM.

The zone is usually divided into five to eight blocks, each headed by a block extension supervisor (BES). A block is divided into eight cells or circles, each run by an extension agent (EA) responsible for transferring agricultural technology to farmers within the cell, working mostly through a select group of farmers called contact farmers. The EA uses mostly the small plot adoption technique (SPAT), which are small plots developed on the farmer's farm to demonstrate new agricultural technologies.

1.5 Literature review

The bases which farmers consider rational for accepting new agricultural technology transcend high yield and economic returns (Dittoh and Ogunfowora, 1985). Farmers place high value on maximum food security, as well as psychological and cultural satisfaction. The small-scale farmers are slower than the large-scale farmers in adopting improved agricultural technology because of their poor resources (Jaiswal and Srivastava, 1976). Similarly, farmers who participate in social organizations tend to adopt agricultural innovations more than individual farmers who do not (Alao, 1974, Osuntogun et al., 1987).

Adoption is a mental process which an individual passes through in deciding whether to use an agricultural technology. Consciously or unconsciously, every farmer goes through certain mental steps (adoption process) before using an agricultural technology (Maunder, 1973). The process has been grouped into a number of steps, with the five and six steps being the most popular. The five-step approach consists of awareness, interest or information seeking, evaluation or mental trial, trial or limited use, and adoption (Lionberger, 1960; Maunder, 1973). The five-stage adoption process has been criticized (Rogers and Shoemaker, 1971). The process implies success, while in reality, rejection can occur before or even after adoption. In addition, the five stages do not always occur in the specified order; some of them may be skipped, especially at the trial stage. In fact, rejection and evaluation can and do occur at all the stages. Furthermore, the process seldom ends with adoption, as more information seeking may occur to confirm or reinforce the decision, or the farmer may reject the technology after the adoption (a discontinuance). Innovations vary in the average length of period of their adoption. The time lapse can vary from days to years. The differences in time of adoption are related to the characteristics of the innovation, through relative advantage, compatibility, complexity, triability, observability and credibility of the change agent (Rogers and Shoemaker, 1971). In Nigeria, researchers such as Welsch (1965); Clark and Akinbode (1968); Basu (1969); Williams and Williams (1971); Patel and Anthonio (1971); Falusi (1976); Opeke (1977); Osuji (1983); Akinola (1986); Ogunbameru (1987); Onyenwaku (1988, 1989), and Iwueke (1989), have investigated factors related to the adoption of improved farm practices and the isolated variables could be grouped into these characteristics: the farmer (age, education, social and tenurial status); the farm (agro-climatic, location, farm size, credit and subsidy); the innovation itself (relative advantages, compatibility, complexity, divisibility and communicability); and the change agents themselves (personal characteristics, techniques of communication and amount of participation obtained). While most of these factors were identified based on adoption scores obtained across many crops and livestock, recent studies on adoption are more content (crop and livestock) and location specific (Obinne, 1991; Njoku, 1991).

Studies devoted specifically to yam minisett technology are few. Onyenwaku and Mbuba (1991) identified cooperative membership and credit to be positively and significantly associated with the adoption of the yam minisett technology, while farming experience was negatively and significantly related to adoption of the technology. Similarly, Iwueke, (1989) found education, farm size and extension contact to be positively and significantly associated with the adoption of the minisett technology, while age of the farmer was found to be non-significant. Chikwendu et al. (1994) reported a high level of awareness and a low level of adoption of the yam minisett technology. The study found age, household size, cooperative membership, tenurial status and intensity of extension services to be significant determinants of adoption of the technology. Iloka and Odurukwe, (1990) found a significant dependence of the proportion of respondents adopting on their location.

The few available studies on adoption of yam minisett technology have concentrated on factors external to the technology itself. Issues such as technology items and reasons for their partial adoption or rejection are yet to be addressed.

Chapter Two: Research Methodology

2.1 The study area and sample

The study was carried out in the southeastern states of Nigeria. The area stretches from latitude 07° 00'N and from longitude 09° 24'E with a total land area of 78,612 km^2. Population density varies between 155 and 403 persons/km^2 with an average of 240 persons/km^2. The population of the area is 18.86 million (1991 Census).

The land surface is dominated by plains under 200m above sea level (Unamma, et al., 1985), and could be classified into three broad relief units: plains and lowlands (including rivers and valleys), cuesta landscapes, and highlands (Ofomata, 1975). According to Bachmann and Winch (1979) and Okorji (1986), the area shares the same ecological features, soil texture, and labour intensive farm operations and accords similar status to yam cultivation as a "man's crop". Agriculture is the main stay of the people's economy. Major food crops are yams, cassava, maize and rice.

Five out of the seven states in southeastern Nigeria were selected for data collection. The selected states are Abia, Anambra, Cross River, Enugu and Imo. From each state, four major yam producing communities (noted for selling their surplus yam products to other communities and give yam prominence in their farming system) and four minor yam producing communities were selected. For each of the community groups (major and minor), consideration was given to communities with records of use of the yam minisett technology. Forty communities were selected for data collection.

From each community, 8 to 10 farmers were randomly selected for interview. In all, 388 farmers were interviewed, and 40 extension agents (EAs) per state were selected. However, a total of 191 EAs including those working in the 40 sampled communities participated in the study.

2.2 Data collection

Data collection involved the use of focus group discussions (FGD) to interact with yam farmers in each selected community before embarking on interviews of selected individual farmers. Data collection covered three areas: interview guides for farmers, community data and questionnaires for the extension agents.

Generally, the interview guide was designed to generate information in the following areas: bio-data and farm characteristics of the farmer; technology information source;

and technology-related variables. On each technology item or step, the farmer was required to give information on: his stage of adoption, [using the seven steps (unaware of rejection) adoption model]; reasons for using or not using; the compatibility of the step, that is, the ease with which the step can be integrated into the farmer's existing yam production practice; the farmer's actual practice in using the step; the need, availability and source of labour and loan; obstacles faced by farmers in accepting and using the yam minisett technology; and farmer-preferred way of removing factors limiting the acceptance and use of the technology.

Community data covered areas such as population density, predominant occupation, nearness to market, exporters or importers of ware yam seed yam, yam production technology capability, location of ware/seed yam production, method of seed yam production and the proportion of farmers using yam minisett technology.

The questionnaire sought information in the following five areas: selected personal characteristics of EAs, EAs' attitude towards the yam minisett technology, issues in disseminating the yam minisett technology and EAs' attitude towards farmers generally.

2.3 Data analysis

Frequencies, percentages and means were used to summarize data on the research questions. Multiple regression analysis with stepwise selection was used to determine the farmer and technology-related variables influencing use of the yam minisett technology. Factor analysis with the principal component technique and varimax rotation was applied to reduce farmers' response to the general issues influencing their acceptance and use of the yam minisett technology into factors. The one-way analysis of variance (ANOVA) was used to test for differences in adoption and the proportion of farmers practising yam minisett technology for selected community variables. Again, two groups each for farmers and communities (those with higher and lower adoption rates) were created and the discriminant analysis performed to attempt an identification of factors responsible for the distinctions, and issues for classifying communities and farmers into high and low adopters a priori, the cut-off point being the mean.

Chapter Three: Results

Yam Minisett Technology-Related Factors Influencing Its Use

3.1 Trends in acceptance and use of the yam minisett technology items

Farmers not aware of the different technology items ranged between 12% and 35% (Table 1). For each of the technology items, 6% to 38% of the respondents were just aware. Few farmers were in the various stages before final acceptance and use (that is between interest and trial). The farmers who had accepted and were using the items of the technology ranged from a minimum of 8% for "crop mixture" to a maximum of 59% for "time of planting," with the majority of items having between 9% and 17% of the farmers using them. Generally, the rate of use of the technology was low.

Farmers who, after accepting and using the technology items, rejected them ranged from 4.5% for "size of tuber for cutting" to 22% for "intercropping". The indication was that for most technology items, more than one third of the farmers who adopted a technology item ended up rejecting it.

Table 1: **Adoption levels for the yam minisett technology items**

Technology items	Adoption stages						
	Unaware	Aware	Interest	Evaluation	Trial	Use	Rejection
Size of tuber for cutting	24.6	36.1	3.7	2.9	11.6	16.6	4.5
Cutting	23.0	27.1	6.6	3.45	16.2	18.7	5.0
Air drying	35.1	30.8	2.1	1.6	10.4	11.3	8.7
Application of minisett dust	22.7	37.4	4.8	1.9	14.0	10.5	8.7
Curring	22.2	37.9	4.5	1.2	10.5	13.2	10.6
Spacing	32.5	37.4	2.9	2.6	12.0	12.9	8.7
Intercropping patterns	22.4	26.1	1.6	2.1	16.9	8.9	22.0
Planting depth	23.8	25.0	2.9	1.6	15.0	10.8	11.9
Time of planting	12.4	5.6	0.3	1.3	3.9	59.8	16.7

3.2 Pattern of use of technology items by adopters (low and high), non-adopters and rejecters of the technology

3.2.1 Adopters (low and high)

Adoption score for each of the nine technology items for low and high adopters of the technology showed that for the low adopters, cutting (1.42), size of tuber (1.11), time of planting (1.08) and drying (1.06) had the highest adoption scores. For the high adopters, spacing (4.36), curing (4.33), minisett dust (4.28) and planting depth had the highest score. The result shows that items most adopted by high adopters were the least adopted by low adopters and vice-versa.

The expectation was that the trend for high adopters would be the same for low adopters assuming both were operating on a continuum for each technology item. A deviation suggests items that need attention. Such items had lower difference scores between high and low adopters. Hence the following variables — size of tuber for cutting, intercropping pattern, cutting, drying and time of planting — may need re-examination by research and extension.

Table 2: **Low and high adopters score for yam minisett technology items**

Technology items	All respondents	Low (L) adopters	High (H) adopters	Difference (H-L)
Curing	3.29	0.78	4.33	3.55
Spacing	3.35	0.88	4.36	3.48
Minisett dust	3.31	0.96	4.38	3.42
Depth	3.28	0.92	4.25	3.33
Sizes of tuber	3.30	1.11	4.20	3.09
Intercropping pattern	2.84	0.82	3.66	2.84
Cutting	3.40	1.42	4.22	2.80
Drying	3.20	1.04	4.08	3.04
Time	3.24	1.08	4.12	3.04

3.2.2 Non-adopters and rejecters

Actual technology practices for two groups of farmers (non-adopters and rejecters) were examined. The results (Table 3) show variations or modifications of recommended technology practices by farmers not adopting or, after adopting, or rejecting a practice. The table shows that farmers were using bigger minisett sizes as planting material. This practice based on farmers' field experiences is consistent with research findings that bigger set sizes increased weight of saleable yam tubers (Onwueme, 1972; Ene et al., 1983; Enyinnaya et al., 1987; Udealor, 1983). The rationable behind the 25g cut weight recommended needs re-examination. The reasons for not adopting or rejecting after adopting are presented in Table 4. The reasons showed that technology items involving measurement and weight, considered to be time consuming or harmful, were modified or regarded unnecessary.

Information in Table 5 further shows that some of the modified or rejected technology items required hired labour and loans to be properly implemented. The table shows that three items in the technology, namely cutting, application of minisett dust and planting (spacing distance and depth) needed and used hired labour. However, the need for and use of hired labour was highest for the planting operation because close spacing results in a higher plant population.

Table 3: **Field practices for yam minisett technology items**

Technology items	Non-adopters	Rejecters
Size of tuber for cutting	Select bigger tubers	Use any available tuber
Cutting	Cut bigger sets;use small seed yams without cutting	Use bigger sets
Air drying	Spread for longer period	Don't use
Application of minisett dust	Use wood ash	Use wood ash; sets do well with treatment
Curing	Air drying	Don't practise
Spacing	Use wider spacing	Don't measure the spacing
Intercropping pattern	After yam, plant maize and other crops	Practise with maize only
Planting depth	Deeper than recommended	Use hoe to open soil for planting
Time of planting	Based on availability of time and labour when rains establish	Based on observation and experience

Table 4: **Most frequently mentioned reasons for non-adoption or rejection of the yam minisett technology**

Technology items	Reasons	
	Non-adoption	Rejection
Size of tuber For cutting	Size of recommended tuber difficult to locate	Lack of planting material
Cutting into minisett sizes	Size too small difficulty in cutting 25 g	————
Air drying	Not necessary	Should not be taken as a separate step
Application of minisett dust	Lack of dust Dust is harmful	Dust unavailble, costly and toxic Time consuming
Curing	Delays farm operation	Time wasting
Spacing	Farm labourers find it difficult to use Time wasting	Involves measurement
Intercropping patterns	The arrangement is complex Waste of farm land	Suppression of crops
Planting depth	Too shallow to measure	No time for measurement
Time of planting	————	To avoid shading of yam by cassava

Table 5: **Need and use of hired labour and loan for items of the yam minisett technology**

Technology items identified	Hired labour		Loan	
	need %	use %	need %	use %
Tuber size	—	—	73.0	18.8
Cutting	47.2	20.6	7.8	3.8
Application of minisett dust	35.9	16.2	33.6	16.7
Planting (spacing & depth)	56.6	36.3	38.4	31.4

3.3 Yam minisett technology items limiting use

To further examine the specific items in the technology that limit its acceptance, the total adoption score was regressed on adoption score for each technology item. The aim was to identify the order and magnitude of each item in explaining the variation in total adoption. The result (Table 6) indicates that the first item to enter the regression equation was curing, followed by depth of planting, use of minisett dust, size of yam tuber for cutting, intercropping pattern, spacing, air drying, cutting and time of planting. The order of items selected gives good information on items that contribute in explaining differences in adoption of the technology. Based on the additional percentage each item contributed to the explained variation in total adoption of the technology (R^2 change), the technology items could be grouped into three. The first were those that contributed at least five percent to explained variation and by implication made the highest contribution in explaining variations in acceptance of the technology. Three items, namely curing (66.5%), planting depth (17.1%) and application of minisett dust (16%) were in this group. The indication is that those who accepted the technology accepted these items. The first two items, it should be noted, required no additional cost to implement. In addition, the farmers unknowingly practised curing, and did not consider the item as an important step to be emphasized in transferring the technology.

Table 6: Summary result of step-wise multiple regression analysis of total technology adoption on technology items

Technology items	R^2 change	Regression coefficient	F
Curing	0.665	0.9788(0.069)	197.1
Planting depth	0.170	1.0025(0.070)	208.9
Minisett dust	0.059	0.9733(0.066)	219.1
Size of tuber	0.025	0.9703(0.071)	188.5
Intercropping	0.019	1.0553(0.053)	399.5
Spacing	0.014	1.0156(0.067)	227.9
Drying	0.010	1.0309(0.061)	289.3
Cutting	0.009	1.0034(0.064)	248.8
Time of planting	0.009	0.9294(0.061)	233.2

R^2 =0.9853(1.8051). R^2 adj.(0.9849); F =2822.7* [*$p < 0.05$] Figures in parenthesis are standard error

The second group of items were those that contributed up to one, but less than five per cent of the variation. Four items were in this group and they include size of tuber for cutting (2.6%), intercropping (2.0%), spacing distance (1.4%), and air drying (1.1%) These items have acceptance problems and call for the attention of extension agents in either changing the transfer methods and emphasis or research in modifying or replacing the items. The technology specified dimensions for the seed yam to be cut into planting sets. Identifying the specified size is a problem in using the item. Field practices show that some modification in the specification had taken place.

Again the intercropping pattern recommended needed some kind of planning and layout which the farmers were not too willing to carry out. This is related to spacing of the crops, particularly in intercropping arrangements, which involve measurement beyond the capability of the rural farmer. Of interest is that air drying of freshly cut sets was grouped as an item that posed a problem. Field observations indicate that farmers who used this item considered it as unimportant or unnecessary thereby rating it as not used.

The third group of items were those that contributed less than one percent to the explained variation. Farmers with a high score on adoption of the technology did not score high in adopting these items. Thus these items were discriminated against. Items in this group were cutting of sets (0.9%) and time of planting (0.9%). Recommended cutting of sets specifies size and weight which, on strict application, involves weighing. Cutting of sets is tied to the problem of size of the yam tuber to be cut. Recommended time of planting, though adopted by the highest percentage of farmers (Table 1), had one of the highest rejection rates.

Chapter Four: Farmer-Related Factors Limiting Use of the Yam Minisett Technology

4.1 Characteristics of farmers

A majority of yam farmers were males (88.2%), ranging in age between 32 and 65 years with an average of 47 years. Data in Table 7 shows that one-fifth of the farmers were illiterates while the majority of them (61%) had only the First School Leaving Certificate (FSLC) which is equivalent to six years of basic formal schooling. Formal education and even literacy is believed to enhance acceptance of agricultural technology.

One quarter of the farmers did not devote any part of their farm land to yam minisett technology. Another 63% had between 1% and 10% of their farm land devoted to the technology.

Table 7: **Distribution of farmers by level of formal education and proportion of total farm land devoted to yam minisett technology**

Level of formal education	percentage (%) of farmers
No formal schooling	14.5
Primary school incomplete	5.9
Primary school complete	60.5
Secondary school complete	11.8
Ordinary National Diploma	2.6
Bachelor's Degree	4.6
Proportion of total farm land devoted to yam minisett	
0%	25.2
1 - 5%	46.5
6 - 10%	16.8
11 - 15%	4.5
16 - 20%	3.2
21 - 25%	0.6
26 - 30%	0.6
31 - 35%	0.6
36 - 40%	1.3
> 40%	0.6

The farmers' first information source about the technology (Table 8) shows that most of them first learnt of the technology through the extension agent (77.5%) and radio (14.5%). This shows the need and importance of a planned effort in agricultural technology transfer. The number of farmers in a year receiving information about the technology for the first time — between 1975 when the technology was first introduced to farmers and 1995 — shows a peak for each of the two institutions responsible for technology transfer during the periods. Each peak period coincides with periods of policy emphasis on agricultural technology transfer in Nigeria. The first, 1982/83, was under the Ministry of Agriculture which was mainly responsible for agricultural technology transfer in the country up to 1986; and the second, 1992/93, was under the ADP, which again was largely responsible from 1987. The year in which more numbers of farmers heard of the technology for the first time corresponds with the period when more numbers of farmers used the technology for the first time.

Under the Ministry of Agriculture, the period 1980-1985 showed steady increase in the percentage of farmers who were aware of or used the technology for the first time, with a drop in 1980/87. The peak period 1984/85 coincides with the national development planned emphasis on root crop production, and the NRCRI yam minisett campaign of 1985. By the end of 1985, emphasis and support for technology transfer shifted from the MOA to ADP, and this could explain the drop in 1986. Similarly, under

Table 8: **Distribution of farmers by year of first information source and first use of technology**

Year	First information source (%)						First use (%)
	Radio	T.V	Farmers	NRCRI	E.A	TOTAL	
1995	1.5	-	-	-	-	1.5	-
1980/81	-	-	-	-	-	-	2.4
1982/83	-	-	-	-	1.0	1.0	4.2
1984/85	-	-	-	-	17.0	17.0	6.0
1986/87	0.5	0.5	0.5	1.5	5.5	8.5	5.4
1988/89	-	0.5	1.0	-	14.5	16.0	8.4
1990/91	-	-	2.0	1.5	13.0	16.5	25.2
1992/93	12.0	-	0.5	-	24.0	36.5	32.9
1994/95	0.5	-	-	-	2.5	3.0	15.6
Total	**14.5**	**1.0**	**4.0**	**3.0**	**77.5**	**100**	**100**

the ADP (1987–1995) for the period the World Bank's financial and other support were available, there was steady yearly increase in the number of farmers who learnt of and used the technology. The sharp drop in 1994 coincides with the reduction in World Bank assistance and the consequent reduction in agricultural technology transfer activities.

Generally, the picture suggests a relationship between emphasis or concentration of extension effort (agricultural technology transfer) and the marginal number of farmers who were aware and used the technology. The implication is that agricultural technology transfer effort should be continuous. Non-continuity of the effort not only results in reduced marginal number of farmers using the technology but has negative influences on those in different stages between technology awareness and use.

4.2 Classifying farmers into low and high adopters of the technology

Attempt at identifying issues which significantly distinguish between a low and higher adopter of the technology yielded five variables (Table 9). The first two variables, namely years of yam cultivation experience and proportion of total farm area devoted to yam cultivation, had negative coefficients indicating that low adopters of the technology were farmers with more years of farming experience. Farmers with less

Table 9: **Discriminant function coefficients of selected variables discriminating between farmers with low and high adoption for yam minisett technology**

Discriminating variables in order selected	Standardized coefficient	Percent contribution	Unstandardized coefficient
Yam cultivation experience	- 0.195	10.25	- 0.016
% of total farm land devoted to yam cultivation	- 0.226	11.88	- 0.006
Participation in social organization	0.511	26.85	0.076
Number of times farmers received information on technology	0.251	13.19	0.024
Proportion of yam farm devoted to yam minisett	0.720	37. 83	0.046

Group centriods = - 0.784(low adopters); 0.322(high adopters)
Canonical correlation = 0.45; % of correct classification =79.1%
Wilks lambda (after function) = 0.797 (X^2 =86.85; df=5; P< 0.01)
F (between pairs of groups) = 19.417; (P < 0.01; df=5, 382)

farming experience tend to adopt the technology. The low adopters had a mean farm experience of 21.6 years, while that for high adopters was 18.9 years. All the farmers in the study area produce ware yam as a tradition, so the higher the proportion of farm land devoted to yam cultivation, the less the area of farm land devoted to yam minisett production. The indication is that farmers who grow less ware yam are more likely to accept the yam minisett technology.

Three additional variables were positive in discriminating between low and high adopters: participation in social organization, number of times farmers received information on yam minisett technology and proportion of yam farm devoted to yam minisett technology. Thus, the high adopters were farmers who participated more in social organization in the community, received more information on the technology and devoted a high proportion of yam farm to yam minisett technology and by implication had more hectarage devoted to yam minisett production.

The five selected issues were significant in discriminating between the groups (F=19.417, P<0.01), and yielded about 79% of correct classification of farmers into groups.

4.3 Classifying communities into low and high adopters of the technology

Yam minisett technology had been developed and disseminated to communities in southeastern Nigeria on the assumption that all the communities need it and will indeed accept the technology. This assumption and practice was examined by: (a) testing the differences in the adoption score for selected community variable; and (b) identifying variables discriminating between communities with low and high adoption score on the technology.

4.4 Difference in adoption between communities

The result (Table 10) shows that there were no significant differences in adoption between communities with respect to ware yam production (major and minor) status, (F=0.50); and location (place) of ware yam (compound and distance farms) production, (F=0.29). Differences in the proportion of farmers practising the yam minisett technology for each of the above variables were similarly not significant.

However, a significant difference in adoption existed between communities which traditionally produce or do not produce seed yam (F=3.96). Similarly, the two groups of communities (minor and major seed yam status) significantly differed on the proportion of farmers practising yam minisett technology. Communities noted traditionally as major seed yam producers appear to have accepted the yam minisett technology better, and have a higher proportion of their farmers practising yam minisett technology than those communities which were not prominent as seed yam producers. The majority of the communities (59%) were not prominent in seed yam production.

Table 10: **Differences in communities adoption and proportion of farmers using yam minisett by selected characteristics**

Community characteristics	Group	Adoption N	Adoption Mean	Adoption F	% using technology Mean	% using technology F
Population density	low	26	28.11	0.71	21.38	1.09
	high	13	31.44		30.23	
Ware yam status	minor	22	28.11	0.50	23.91	0.01
	major	16	30.86		23.31	
Seed yam status	minor	23	26.33	3.96*	14.61	9.40*
	major	15	33.77		37.53	
Location of ware yam production	compound	9	32.15	0.75	24.11	0.001
	distant	30	28.34		24.40	
Location of seed yam production	compound	10	27.52	0.29	19.00	0.61
	distant	29	29.81		26.17	

*$P < 0.05$

4.5 Factors discriminating between communities with high and low adoption of yam minisett technology

Four out of the 24 community variables examined were selected as significant in discriminating between communities in which the average adoption score of the farmers was low (Table 11). These variables and their percentage contribution to the total discriminant score are: knowledge level of ware yam production (38.36%); proportion of farmers practising yam minisett technology (22.88%); distance of community to the nearest major ware yam market (23.27%); and experience of the extension agent working in a community (15.48%). Communities rated high on level of existing knowledge of ware yam production did not accept the yam minisett technology. Put differently, the less knowledge of ware yam production, the higher the probability of a community accepting and using the minisett technology. The inclusion of the variable "proportion of farmers practising yam minisett technology," was expected as communities with a higher percentage of their farmers using the technology should have a higher adoption score. The result further showed that the farther away (more than about 6 km) communities were from a major ware market, the higher the chance of the community accepting the yam minisett technolcgy. The indication was that communities close to a major yam market tended to be influenced (lured) more into ware yam production with an all year round demand, which the market assures, and tends not to accept the production of seed yam, which does not enjoy all year round

Table 11: **Discriminant function coefficients of selected variables discriminating between communities with high and low adoption for yam minisett technology**

Discriminating variables in order selected	Standardized coefficient	Percent contribution	Unstandardized coefficient
Knowledge of ware yam production	- 1.177	38.36	- 1.236
% of farmers practising the technology	0.702	22.88	0.033
Distance to major yam market(km.)	0.714	23.27	0.296
Agents' years of extension experience	- 0.475	15.48	- 0.486
			(constant) 0.336

Group centriods = -1.667(low adopters); 0.715(high adopters)
Canonical correlation = 0.749; % of correct classification = 96.67%
Wilks Lambda (after function) =0.439(X^2 = 20.56; df =4; P < 0.01)
F (between pairs of groups) = 4.892; P < 0.01.

demand. Thus, producing ware yam becomes more lucrative and ensures a regular source of income for communities close to a yam market. Communities far from a major yam market have less advantage in marketing their ware yam because of additional cost in frequent transportation. Thus, they may consider accepting the production of seed yam which could be transported and sold over a short period of time (beginning of planting season), thereby reducing handling charges.

Communities that had extension agents with more years of extension experience adopted the technology less than those with less experienced extension agents. It is likely that experienced extension agents were chronologically older and less likely to vigorously disseminate the technology or were already frustrated by their earlier experiences in disseminating the technology that they had rejected. In addition, it should be pointed out that recently recruited extension agents in the study area have higher academic training, usually a Bachelor's Degree in agriculture, than their older colleagues with Diploma Certificate. It is possible that the qualification of agents had some effect on the observed result.

Two of the selected variables which could be used to identify a community before introduction of the technology were "ware yam production knowledge" and "distance to major ware yam market". The third variable related to the extension agents has implication for the agency responsible for transfer of the technology. After identifying the communities for initial transfer, there is the need to assign newly recruited and probably younger extension agents to such communities. The major idea here is the categorization of major target groups for the transfer of the technology. Similar suggestions have been made by Swanson et al. (1984), Fliegel (1984), and Collins (1991). According to Thapa et al. (1994), the nature of variability is such that any attempt to design technology for large numbers of farmers will usually fail. This may be either because the technology itself is inappropriate for most farmers or technologies that accommodate the high degree of flexibility found in farming systems have yet to be developed.

4.6 Farmer-identified issues limiting use of the technology

The identified issues were grouped for policy relevance (Table 12). The five meaningful factors in order of importance were named as: poor marketing facilities, cultural complexity, complex processes, costly inputs and knowledge.

Poor marketing facilities accounted for 28% of the issues and pointed to lack of market for technology product (0.86), poor economic returns (0.69) and poor storage (0.59). Unlike ware yam, which has market demand throughout the year, products of yam minisett technology (seed yam) have market demand for only about two months (during the planting season) during the year. Thus users of the technology will have to wait for some time before turning their products into cash. The situation demands a high degree of discipline in husbanding the revenue over a long period of time before another short period of sale, which does not suit the life pattern of rural dwellers with poor financial institutions such as banks. From this perspective, the farmers saw the technology as a production activity that provides revenue at specific times of the year and probably for specific purposes; and not a technology to be accepted as an agricultural business providing revenue for their needs throughout the year. This is closely associated with the issue of poor economic returns pronounced by the expectation of higher economic returns from a technology with paid inputs. Harvesting of yam minisett products is usually done around November/December and must be stored up to April/May of the following year (5 months) before sales can start. This puts pressure on storage facilities and results in increased loss through decay. Ware yam production in the study area is carried out based mostly on social, cultural and religious considerations, with very little emphasis on economic returns (Ebong et al., 1971; Okorji, 1988). On the other hand, economic factors appear to be an important consideration in accepting and using the yam minisett technology.

Cultural complexity accounted for about 25% of the issues limiting use of the technology and was defined mainly by the technology having conflict with the people's norms (0.69) and the technology not being easily integrated into the prevailing farming system (0.55). The indication was that the minisett technology was in disagreement with the

Table 12: **Varimax rotated factor matrix of issues limiting farmers' use of the yam minisett technology**

Issues	Factors				
	I Marketing facility	II Cultural complexities	III Complex process	IV Input	V Knowledge
Awareness of the technology	0.11	0.11	0.12	0.08	0.65
Scarcity of farm land	0.13	0.57	0.11	0.30	0.11
Conflict with norms	0.40	0.69	0.22	0.00	0.15
Difficult to propagate	0.34	0.53	0.38	0.10	0.10
Not easily integrated into farming system	0.41	0.55	0.45	0.01	0.01
Costly to implement	0.22	0.29	0.24	0.40	0.09
Poor economic returns	0.69	0.28	0.13	0.16	0.27
Lack of market for technology product	0.86	0.30	0.14	0.04	0.04
Poor storage	0.59	0.16	0.41	0.06	0.04
Unavailability of inputs	0.01	0.03	0.16	0.67	0.06
Costly inputs	0.07	0.10	0.02	0.72	0.02
Dust is toxic	0.31	0.33	0.43	0.20	0.02
Technology is complex	0.28	0.39	0.61	0.07	0.15
Many steps in using the technology	0.11	0.13	0.71	0.26	0.17
% of explained variation	28.47	24.56	22.15	17.22	7.59

existing yam production practices in the study area. Apparently, the process of generating the technology puts more emphasis on economic viability and technological feasibility and less on cultural compatibility with traditional farming systems. While intercropping, with many crops planted on the same mound or side/row of a ridge, is the traditional yam production practice (Okorji, 1986), yam minisett technology was introduced first as a sole crop and later as a mixed crop with alternate row arrangement, requiring the farmer to plant one type of crop on each row/side of a ridge.

Factor three — complex process — accounted for 22% of the issues limiting use of the technology. This factor was dominated by "many difficult steps in using technology" (0.71) and the "technology complex" (0.61). This complexity is expressed because the technology requires a farmer, used to planting whole tubers of unknown weights, to change to yam minisetts that have to conform to certain weights and treatment before planting (Madukwe, 1995).

Inputs accounted for 17% of the issues, prominent was "costly inputs" (0.72) and "unavailability of inputs". In Ghana, lack of inputs was a major frustration in accepting agricultural technology (Owusu-Baah, 1995).

Factor five was knowledge, which accounted for only about eight per cent of the issues. Principally dominated by "awareness of the technology" (0.65), this was an indication that most of the farmers were aware of the technology.

Viewed generally, challenges to yam minisett technology transfer identified by farmers were more non-technical. Petit et al. (1992) emphasized the need to involve both the private and public sectors in facing the non-technical challenges to technology transfer.

4.7 Farmer-preferred ways of removing the limiting factors

Farmers, as principal users of the yam minisett technology, gave suggestions on ways to remove the factors limiting acceptance and use of the technology (Table 13).

Provision of needed inputs was suggested by about 74% of the respondents. These included ware yam for cutting, minisett dust and fertilizer. Ware yam for planting, compared to the planting material of other food crops, is relatively expensive. The minisett dust, though not expensive, is not readily available in rural farm areas. Fertilizers are relatively unavailable and expensive. Therefore, any arrangement that takes the input burden off the farmers will encourage use of the technology.

Seventy-one percent of the respondents recommended provision of subsidies and credits. Subsidies would make the inputs less expensive and affordable by farmers, while credit would allow them to pay for physical inputs and labour, complimenting the suggestion on provision of inputs for the farmers.

Again, about 70% of the respondents would want Government to buy the yam sets from farmers. Other suggested solutions were "ensure agents regular visit and demonstration to farmers" (67%), "reduce steps involved, review size of minisett sets and intercropping pattern" (62%) and "encourage contract growers (62%). Contract growers are farmers who, with the provision of all needed inputs by a government or private agency, devote their farm land and time to producing a farm product using specified agricultural technology. Marketing of the farm products is assured by the funding agency.

Table 13: **Farmer-suggested solution to issues limiting adoption of yam minisett technology**

Issue	% indication
Provision of needed physical farm inputs	73.5
Provision of subsidy and credit facility	70.6
Procurement of technology product from farmers	69.8
Regular visits and demonstrations by extension agents	67.3
Reduce steps, review cut sizes and intercropping pattern	61.9
Encourage use of contract growers	61.7

Chapter Five: Conclusion

Based on the findings, the major policy issues in yam minisett technology are highlighted. The level of cultural affinity for yam and its central position in the farming systems of southeastern Nigeria mark issues related to the transfer of its improved technology as a reflection of the general effort in the study area.

The marginal effect on output of using bigger yam tubers for cutting and bigger planting sets should be investigated by research. Similarly, research should develop less complex and more appropriate mixed cropping patterns for the technology. Again, the need for air drying and curing as separate steps of the technology should be re-examined. Attempts should be made at reducing the steps in using the technology. The long list of steps paints a complicated picture which intimidates the farmer.

Using the recommended spacing distance on different sizes and patterns of mound (land preparation) was difficult for the farmers. Recommendation for spacing should be worked out for the prevailing land preparation patterns in a geographic area. Another difficulty experienced was in making measurements needed to use the technology items. This suggests the need for the extension agent to re-emphasize the concept of using natural body features and objects around him as measures.

The consequences of modifying each item in a technology should be envisaged, tested and built into the package to be transferred to farmers. Presenting agricultural technology in an iron-clad cover without alternatives tends to intimidate most farmers. The few who eventually try the technology end up noting its non-usefulness and consequently modify the technology to suit them. This capacity to modify must be taken into consideration in developing agricultural technology, allowing for alternatives and ranges and thus becoming worthy of initial trial by most farmers.

We now know that communities differ in their capacity to use agricultural technology, even when physical conditions such as soil and climate are the same. Again, the view and policy orientation that traditional ware yam producing communities are more likely to accept the minisett technology is not supported by this study. Even within communities, the assumption that every farmer will accept the technology cannot hold. Farmer selection becomes a sensible policy option. Younger farmers who are new in yam production with less land devoted to ware yam production appear more receptive to the technology and should be the target of initial transfer.

Agricultural technology transfer agencies should ensure that effort at transferring a particular agricultural technology use a multiple transfer approach over a long period of time. One such additional approach is the radio.

The drop in the number of farmers using the technology when support for the transfer effort was reduced, not only underlines the importance of such support but also emphasizes the need for proper planning of agricultural technology transfer programs. It is important at the field level that transfer efforts should be tied to available resources, financial and otherwise. The number of agricultural technologies and the time period needed to establish a good measure of acceptance must be worked out from the outset. This is closely tied to the issue of concentrating effort on communities and farmers with high potential for accepting the technology. These recommendations arising from the absence of a policy backing the yam minisett technology transfer are areas where policy efforts should be concentrated. More importantly, technology transfer agencies should articulate official statements with specific purpose, set objectives and defined outcomes for each agricultural technology to be transferred.

Modern agricultural technologies are based on heavy doses of farm inputs. Availability of inputs for specific agricultural technology is a necessary condition for accepting the technology. Farmers react to non-availability of inputs in many ways. One is not to accept the technology at all. Two is to partially accept the technology, that is the non-input aspect and reject the farm inputs. Three is to accept the technology and later reject it. Four is to accept the technology and modify or substitute the unavailable inputs. Substitution may have a negative or positive effect on technology output. In the absence of a developed farm input supply system, Government should take direct responsibility for making farm inputs available to the farmers, including subsidies and credit for such inputs.

From our analysis and farmers' suggestions there is need for government to deliberately intervene in the market structure for yam minisett technology, to reduce the long waiting period and liquidity problem associated with it. Agricultural technology transfer agencies should realize that the disposal of technology products, beyond getting the farmer to use the technology, is a very important aspect of technology transfer which greatly influences use or non-use.

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